Geoscience Education in the Boy Scouts of America

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ABSTRACT

Boy Scout geoscience education is not "desk" education—it is an informal, hands-on, real-world education where Scouts learn through activities, trips, and the outdoors, as well as in meetings and in the merit badge program. Merit badge requirements, many of which meet National Science Education Standards for Earth and Space Science, give boys foundational experiences and familiarity with geoscience topics. Earning a Geology merit badge at any location resulted in a significant gain of content knowledge ($P < 0.001$). The combined treatment groups for all location types had a 9.2% gain in content knowledge, but the amount of content knowledge acquired through the merit badge program varied with location. The longitudinal posttest scores, with a 15.0% increase from the attributed average pretest score, were higher than the posttest scores from any location except summer camp. No gains were seen in the control group; age and grade were not significant factors. Combining interview data with quantitative data indicates that Scouts who participate in the Geology merit badge are better prepared for school geoscience classes. Participation in the Geology merit badge provides geoscience experiences and "familiarity" with geoscience concepts that allow Scouts to create and retain geoscience knowledge. [DOI: 10.5408/09-192.1]

Key words: Boy Scouts, Boy Scout education, experiential education, free-choice education, Geology merit badge, geoscience education, hands-on, informal education, merit badge, outdoor education, science education, Scouts, Scouting

GEOSCIENCE EDUCATION IN THE BOY SCOUTS OF AMERICA

> *A boy is not a desk animal. He is not a sitting-down animal . . . He is a boy*—God bless him—full to the brim of fun and fight and hunger and daring and mischief and noise and observation and excitement. If he is not, he is abnormal. (Baden-Powell, 1920)

> The sciences, the Geology merit badge, the Conservation merit badge, the Astronomy merit badge, all of those piqued my curiosity, and, I think, helped lead me into this career program. (Sherman Lundy, geologist)

INTRODUCTION

The Boy Scouts of America (BSA) organization may be one of the largest providers of long-term informal science education and geoscience education in the United States, because Boy Scouts make up 14% of the population of boys between the ages of 11 and 18 (BSA, 2008c). According to the BSA director of research, 898,320 boys were enrolled in the traditional Boy Scout program as of December 31, 2009. Between 1911, when the merit badge program was established in the United States, and 2008, Boy Scouts earned 489,419 Geology merit badges; Boy Scouts earned 19,525 Geology merit badges during 2007 alone. Between 1911 and 2008, Scouts earned 1,023,560 Soil and Water Conservation merit badges, including 13,630 in 2007 (BSA, 2008c).

Purposes of the Study

The Boy Scouts have always emphasized education, especially in the natural sciences. The educational agenda has an active, outdoor component emphasizing outdoor learning through camping, hiking, and other outdoor activities (Nicholson, 1940; BSA, 1998). Lord Baden-Powell, the founder of the Boy Scout Movement, associated the study of nature—animate, inanimate, biology, plants, and animals—with the pursuit of happiness.

The aims of the study are to determine whether participating in Boy Scout activities, particularly the Geology merit badge, helps boys increase their geology content knowledge and prepares them to do better in school geoscience classes by providing experiences, memories, and knowledge upon which the boys can build further knowledge.

Background on Scouting

Literature Review

Little research on Scouting exists in science education literature. A science education study was conducted with Cub Scouts in Great Britain, but according to the director of research for the BSA, who researches and collects information printed about the Boy Scouts, the BSA has no record of research on science education or geoscience education in the BSA. In a study conducted to ascertain Scout interests, boys in the BSA indicated that participation in Scouting helps increase their interest in science, because they are exposed to, and experience, science at many levels and in many locations (BSA, 2005).

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Learning and Knowledge Construction

Previous learning is important for new knowledge building, because encoding depends on previous knowledge and is most successful when it links to multiple aspects of an individual's experience (Bell, 2001). However, learning must involve the use of memories to connect ideas or solve real-world problems (Falk and Dierking, 1997). Nonformal educational experiences, which include many Scouting activities, link experience with reality (Silberman-Keller, 2003).

BSA is a form of free-choice education. Each boy who enters the Scouting movement may choose to become Boy Scout; may choose how fast, or whether, he advances in rank; may choose which merit badges to work on; and in some instances, may choose among options in fulfillment of a requirement for a merit badge.

Scouts are taught using a hands-on approach (Jarman, 2005; Nicholson, 1940). This hands-on approach works well with the tactile, kinesthetic needs of boys (Hlawaty, 2002; Honigsfeld and Dunn, 2003); boys are highly tactile and prone to tinkering, wishing to master and quantify their physical environment (Heard, 2000). Knowledge presented in school classrooms is often decontextualized and inert (Schugurensky, 2006). By tinkering with objects in the learning environment, boys gain confidence, authority, and a willingness to explore further (Heard, 2000). When learning is associated with doing, knowledge is acquired within the context of the activity; thus, it is active and vital (Schugurensky, 2006).

When learners do hands-on science, they directly influence their cognitive development by constructing knowledge about events and circumstances. Cognitive development is also influenced indirectly by hands-on science, because memories are formed that can be recalled in later knowledge construction (Wellington, 1990).

Jarman (2005) identified Scouting as an understudied environment in which informal science education occurs. Jarman further emphasized that the science experiences in Scouting "exemplify science ideas encountered within the school curriculum." In addition, Jarman theorized that if Scouts can remember their experiences and relate them to topics presented in formal school activities, the experiences may connect for the Scouts and help them to develop "deep conceptual understanding." In informal education, the "experience is everything"; experiences that are just for fun can have significant consequences (Stocklmayer and Gilbert, 2002). Jarman identified four contexts in which science is transmitted in UK Scouting: the Progressive Training Program (which corresponds to rank advancement requirements for U.S. Scouts); proficiency badges, (similar to U.S. Scouting merit badges); special events, such as visits to science centers or working on environmental projects; and incidental learning, in which science learning is not the primary goal of the activity but is a potential outcome of a particular activity or experience (Jarman, 2005; BSA, 1998). Geoscience education in the BSA falls into three of these categories: merit badges, special events, and incidental learning; however, geoscience knowledge is not a rank advancement requirement (BSA, 1998). The experiences Scouts have while doing optional geoscience-related merit badges, camping, canoeing, hiking, backpacking, caving, exploring, working on projects, and doing other activities provide them with personal experiential knowledge that can be used to construct knowledge both at the time of the experience and in later formal school activities.

Scouting provides boys with field-based activities. Field-based geoscience experiences enrich education by stimulating interest and natural curiosity, providing a sense of scale (both time and dimension), and challenging students to move beyond simple recollection of facts (Garrison and Endsley, 2005; May and Gibbons, 2004).

Merit Badge Pamphlets

The BSA program includes experiential activities through which boys are involved in a variety of learning experiences. A printed educational curriculum is available to every Boy Scout in the form of the Boy Scout Handbook and more than 120 merit badge pamphlets on a variety of topics. The BSA educational material, edited and published by the BSA, is produced by experts in each subject (Steele, 2008). Merit badges, although not created to meet National Science Education Standards (National Research Council, 1996), align with the standards and provide boys with many opportunities to learn geoscience (available in Supplementary Table 1 at: http://dx.doi.org/10.5408/09-152s1). Ten merit badges have earth/space requirements meeting grades 5–8 National Science Education Standards, and 11 merit badges have earth/space requirements meeting grades 9–12 National Science Education Standards. (Energy is not a grades 5–8 earth/space standard.) Boys are not required to complete any merit badges unless they wish to advance in the Boy Scout program; merit badge participation allows free choice in both participation and choice of topic. For a boy to earn a merit badge, he must complete the listed requirements published in the specific BSA merit badge pamphlet.

All boys desiring to earn the Geology merit badge must complete the universal requirements listed in the *Geology* merit badge pamphlet, in addition to completing one of four options of study: (1) surface and sedimentary processes (category A), (2) energy resources (category B), (3) mineral resources (category C), and (4) earth history (category D). Field-based experiences "provide stimuli for continued pursuit of natural philosophy and as catalysts for team work, mentoring, and sharing knowledge with others" (Garrison and Endsley, 2005). Many requirements for the Geology merit badge, including the universal requirements and the requirements for each option, include field visits as one of the options for completing the requirement. The visit choices available in the Geology merit badge include (1) visiting with a professional in a geology-related field; (2) visiting and studying a stream; (3) visiting an operating drilling rig and talking with an onsite geologist; (4) visiting an active mine, quarry, or sand or gravel pit; (5) visiting a science museum or a university geology department display; or (6) visiting a local structure built with fossiliferous rocks (BSA, 2008a).

RESEARCH QUESTIONS

The researchers, using a pretest–intervention–posttest design, attempted to discover (1) whether participation in the BSA Geology merit badge program engendered Scout geoscience knowledge, (2) whether the amount of geoscience knowledge gained varied by location, and (3) whether Scouts retained geoscience content knowledge acquired through participation in the Geology merit badge.

Interviews were conducted to illuminate how participation in the Boy Scouts influenced Scout geoscience knowledge, to determine whether participation in the Geology merit badge was influential in determining longitudinal posttest scores, and to learn whether Scouts were able use knowledge and experiences gained while doing the Geology merit badge to construct knowledge in their geoscience classes in school.

HYPOTHESES

Scouts who participate in the Geology merit badge, regardless of location, will increase their geoscience knowledge compared with Scouts who do not participate in the Geology merit badge (control group), as shown by differentials between pre- and posttest scores ($P < 0.05$). (Null hypothesis: The differentials between pre- and posttest scores of Scouts earning the Geology merit badge will equal the differentials between pre- and posttest scores of Scouts not earning the Geology merit badge.)

Scouts doing the Geology merit badge at any location acquire the same content knowledge by using the same educational material. The amount of content knowledge acquisition will not vary by location. Content knowledge gain will be equal at all locations, and the differentials between pre- and posttest scores will be equal ($P < 0.05$). (Null hypothesis: The content knowledge acquired by Scouts earning the Geology merit badge at different locations will vary, as shown by the differentials between pre- and posttest scores of Scouts.)

Scouts succeed in formal geoscience education by building on their Boy Scout geoscience experiences and studies, especially their Geology merit badge experiences. Scouts who have earned the Geology merit badge will show an increase their geoscience content knowledge beyond that of Scouts who only participate in school geoscience education, as shown by differentials between the assigned pretest score and the posttest scores of Scouts who had previously taken the Geology merit badge compared with the pre- and posttest score differentials of Scouts who had not taken the Geology merit badge ($P < 0.05$). (Null hypothesis: The differentials between the assigned pretest score and posttest scores of Scouts who previously earned the Geology merit badge will equal the differentials between pre- and posttest scores of Scouts not earning the Geology merit badge.)

Interview data will illuminate how boys use their Boy Scout experiences, including their merit badge experiences, to construct knowledge in their school geoscience classes.

METHODS

This study combined qualitative and quantitative methods. A variety of data sources were used to verify the research findings through triangulation, member checks, and transferability (Corbin and Holt, 2005; Talburt, 2004). Two populations were studied: a population that participated in the quantitative section of the research and an interview population that participated in the qualitative research. The researcher who collected the data passed the criminal background check required by the BSA to work with Boy Scouts (BSA, 2008b). Informed consent was secured from all participants and the parents of youth participants.

Socioeconomic factors were not included, because BSA does not track enrollment by socioeconomic status on either the local or the national level. According to a spokesperson from the local council, Boy Scout recruitment activities are similar in all parts of the country, and according to collected membership information, local membership is comparable to other councils in the Midwest.

Quantitative Methods

The quantitative portion of the research, using pre- and posttests, was used to determine the amount of geology content knowledge engendered in the Scouts completing the Geology merit badge and to determine whether Scouts retained this content knowledge gain.

Quantitative Research Participants

The three self-selecting populations in the Geology merit badge portion of the study ($n = 139$) included boys who were members of the control group ($n = 36$) and took a pre- and a posttest but did not work on earning the Geology merit badge; boys who were members of the longitudinal study ($n = 23$) and had, at some time since becoming a Scout, earned the Geology merit badge and participated in the study by taking a posttest; and boys who earned their Geology merit badge ($n = 80$) and took a pretest and a posttest.

Quantitative Research Settings

Data collection sites for the Geology merit badge included

- three Boy Scout summer camps,
- a landmark site,
- a merit badge college conducted at a community college and quarry, and
- the meeting sites for two Boy Scout troops.

The Boy Scout camp areas were all located in roofed shelters with no walls. The landmark site had an educational area in which to collect the data. The pretest at the merit badge college was administered in a classroom; the posttest was completed at a quarry. The two Boy Scout meeting sites were in church activity rooms. The summer camp program was 5+ hours in the course of 1 week, the 1-day program at the landmark lasted 3 hours, the 1-day merit badge college program was 6+ hours, and the troop programs were 6+ hours over the course of 2 or 3 months.

Quantitative Research Data Collection

All Scouts earning the Geology merit badge used the same educational material; pre- and posttest data were collected from Scouts earning the badge in different locations. Face validity was achieved by matching the instrument questions to the requirements in the Geology merit badge handbook. The content validity of the instrument constructed for this investigation was determined by a panel of expert judges in the fields of geology and science education. Construct-related evidence of validity was seen in the posttest score gain after Scouts completed the Geology merit badge. The reliability of the instrument was ascertained through a pilot study in which the correlation between paired pre- and posttest scores was significant at the 95% confidence level ($n = 16$).

TABLE I: Research design.

Location	Pretest	Merit Badge	Posttest
Camp			
No badge (control group)	O		O
Previous badge (longitudinal group)	Average of all pretest scores across control and treatment groups	X (earned badge previously)	O
Current badge	O	X	O
Landmark	O	X	O
Merit badge college	O	X	O
Troop event	O	X	O

As random sampling was not feasible, the quantitative design for testing the efficacy of the *Geology* merit badge pamphlet in engendering geoscience content knowledge was a combination of quasi-experimental designs developed by Campbell and Stanley (1963). Scouts in the control group and Scouts who participated by taking the Geology merit badge during summer camp took their pre- and posttests at the same time, at the beginning and at the end of the summer camp week. Scouts who had already taken the Geology merit badge were given the posttest to determine whether there were long-term geoscience content knowledge differences between Scouts who had taken the Geology merit badge and Scouts who had not (Campbell and Stanley, 1963). Scouts who did the Geology merit badge at weekend events and at summer camps and Scouts taking the merit badge with their troops were given pre- and posttests. The combined results from all locations were compared to see whether there was a significant difference in science content knowledge between the Scouts earning the Geology merit badge and the control group of Scouts who did not earn the badge. The results from each type of location were compared to see whether there was a significant difference in science content knowledge acquisition by type of location. The longitudinal results were compared with the control results to determine whether Scouts retained content knowledge.

Table I shows the experimental data collection design, modeled after Campbell and Stanley (1963), where O represents testing and X represents completion of the Geology merit badge. The table indicates what data were collected, where data were collected, and whether a merit badge was awarded. Pre- and posttest data were collected from all locations to determine whether location made a difference in content knowledge gained.

The use of a nonequivalent control group for the Scouts taking the Geology merit badge at summer camp was designed to control for internal sources of invalidity of history, maturation, testing, instrumentation, selection, and mortality but not for interaction of selection and maturation. As neither the control nor the experimental/treatment groups was chosen for extreme scores, regression to the mean was not an issue. The experimental group deliberately sought exposure to the treatment by taking the Geology merit badge; the control group consisted of Scouts attending summer camp and taking merit badges other than Geology. The probability of selection interaction may have been increased, because boys who selected to take the Geology merit badge may have had more geoscience interest than boys who did not select to do Geology. Using the nonequivalent control group did not control for external sources of invalidity, such as the interaction of testing and intervention. But because the Scouts were not randomly pulled out of a program to participate in an intervention, these threats were less than they would have been in a true experimental design with random assignment to intervention and control groups (Campbell and Stanley, 1963). Separate control groups for Scouts taking the merit badge for a weekend or troop event were not possible; the control group from summer camp was used as the control for all treatment locations/groups. Maturation and outside influence at troop events and for the longitudinal sample were more likely than during the 1-day events at the landmark and merit badge college or during the 1-week events at summer camps. The possibility exists that some Scouts participating in the troop events or in the longitudinal sample were exposed to geology content knowledge in a school setting before taking the posttest.

Quantitative Research Instrument

The pre- and posttest consisted of 23 multiple-choice questions, including 4 questions about three diagrams (Geology Assessment is available at: http://dx.doi.org/10.5408/09-152s2). The questions and distractors were selected to align with the rocks and minerals option of the Boy Scout Geology merit badge. These questions were designed to test knowledge of the rock cycle and associated processes, rock and mineral structure, mineral identification tests, and principle of superposition.

Qualitative Methods

Interviews with Scouts provided qualitative information used to determine whether participation in the Boy Scout program engenders earth science content knowledge and prepares Scouts to construct geoscience knowledge, as well as to determine whether Scouts perceived interaction between geology content learned in Scouting and geology content learned in school.

Qualitative Research Participants

Interview data ($n = 4$) were collected from older Scouts, because they had more experience with Scouting and therefore had been exposed to more science in the Boy Scouts than younger Scouts had. Interviewees included three high school juniors and one senior; three of the Scouts were 16 years old, and one was 17. All four Scouts had achieved Life Scout Rank and were working toward their Eagle Rank. The oldest Scout was preparing for his Eagle Board of

Review; the younger Scouts were finishing their last Eagle-required merit badges. The Scouts were all from different troops and locations in the metro area of a capital city, and two were casual school acquaintances.

Qualitative Research Settings

Data were collected in the Midwest. The interviewees chose the location for their interview. The settings for the interviews varied and included the home of one of the interviewees, a neighborhood pool where one of the interviewees worked, and public education locations. Interviews were conducted using the Boy Scout policy of no unsupervised one-on-one interaction.

Qualitative Research Data Collection

Interviews, to collect qualitative data, were conducted to demonstrate the effectiveness of the Geology merit badge in preparing Scouts to succeed in formal geoscience education and to determine whether Scouts used their geoscience knowledge data in school geoscience classes.

RESULTS

Quantitative Research Results

The Scouts making up the control group ($n = 36$, average age = 12.9 years) took pre- and posttests at the same times and places as did the boys who did the Geology merit badge at the camps. The control group varied in age, grade, and Scout rank but did not differ significantly ($P < 0.001$) from any treatment groups.

The pre- and posttest differential scores of the control sample were compared to the pre- and posttest differential scores of the combined treatment groups ($n = 80$) (Supplementary Table II, available at http://dx.doi.org/10.5408/09-152s3). The combined treatment groups improved their test scores by 2.1 questions, with a significant 9.2% gain in content knowledge ($P < 0.001$).

Content knowledge gain, as shown by pre- and posttest differential scores, was compared by location. Twenty-two boys (average age = 13.0 years) in two troops participated and earned their Geology merit badge by working with a merit badge counselor as a troop. Eleven boys at three camps (average age = 13.0 years) earned their Geology merit badge and participated in the study. Thirty-three boys (average age = 12.3 years) participated in the study at the landmark location, and there were 14 participants (average age = 13.0 years) at the merit badge college.

Using SPSS, a univariate analysis of variance full factorial model, which consisted of all interactions except grade, because age and grade were highly correlated, was performed. The interactions included treatment group, location, time length, Scout rank, and age. No interactions were deemed significant; therefore, a main effects model was produced. The treatment location, Scout rank, and age were put in as main effects. Treatment locations were deemed significant with a 95% confidence level (Supplementary Table II). The scores of Scouts in the control group during the week at summer camp decreased by an average of 1.2 questions, a 5.0% decrease. Scouts at summer camp increased their scores by an average of 4.1 questions, a 17.8% increase. The Scouts who worked as a troop with a merit badge counselor improved their scores by an average of 3.0 questions, a 13% increase. The Scouts at the merit badge college improved their scores by an average of 2.1 questions, a 9.0% increase. The Scouts at the landmark improved their scores by an average of 0.9 questions, a 4.0% increase. Score increases at all locations were deemed significant with a 95% confidence level. Figure 1 shows the pre- and posttest differential in the number of correct answers at the various treatment locations.

The 23 boys in the longitudinal sample completed the Geology merit badge before the study; the time length between the completion of the merit badge and the posttest was unknown and varied within the sample. The boys were of different ages, grades, and Scout ranks. These Scouts took a posttest; a pretest score, the average sum of the pretest scores across the control and treatment groups, was attributed. The average age of the longitudinal sample was 14.75 years; the average age of the control was 12.9 years. Age and grade level were highly correlated ($P = 0.984$). A one-way analysis of variance technique measured the effect of age within the treatment groups. Age was not a significant factor when looking at its effect on the treatment groups (longitudinal versus control) and predicting the score differential. The geology content knowledge gain in the longitudinal sample (Fig. 2) was significant at a 95% confidence level ($P < 0.001$). The longitudinal sample posttest scores were, on the 23-question assessment, 3.4 questions higher than the attributed pretest average score, a 15.0% change. This score increase was higher than score increases at any location except summer camp.

Qualitative Research Data and Analysis

Science experiences are naturally embedded in the Boy Scout program. Camping and engaging in outdoor activities expose Scouts to many aspects of science, including geosciences. These outdoor experiences provide experiential knowledge upon which further knowledge can be scaffolded, in and out of school. The experiences provide a relationship between out-of-school life and school-subject material, making the school material relevant and of more interest.

Scout K indicated that the experiential knowledge base that he gained in outdoor experiences, including camping, was important in helping him learn science in school by making his formal science education relevant. Scout K explained the effect of outdoor experiences in learning science by saying:

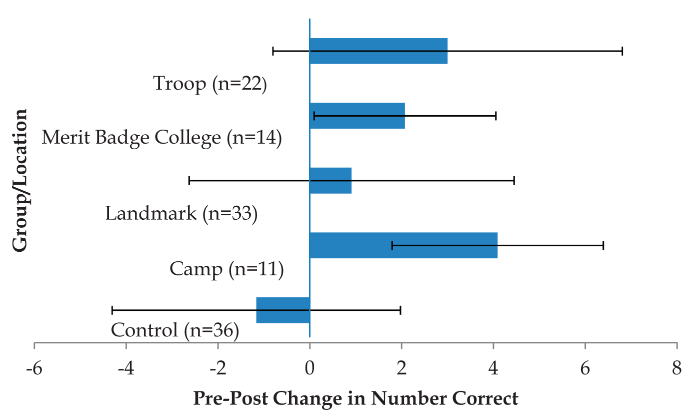

FIGURE 1: Group/location versus pretest–posttest change in number of correct answers.

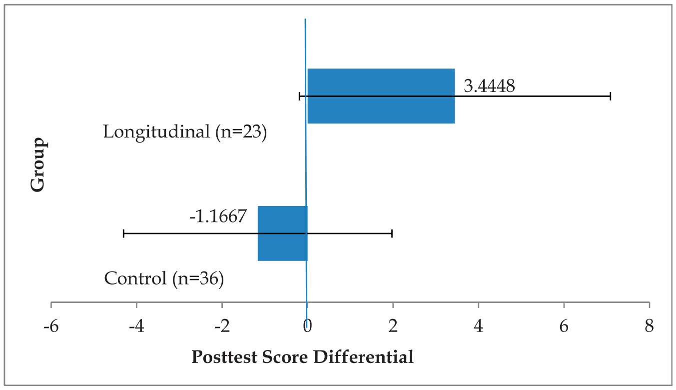

FIGURE 2: Control versus longitudinal posttest score differential.

> *"Experiencing the outdoors helps, and then we learn about botany and different things, different plants, different animals. How, like when we're climbing a mountain, like how that mountain was formed, like by a volcano, or how it was started, like a rock. Geology, botany, and animal sciences—different things like that help with science. . . . Personal experience in Scouting is a lot better science than school science, 'cause you actually get the experiential of it."*

Sometimes science knowledge acquisition may be an incidental byproduct of Scouting activities. Scout J felt he learned science incidentally, just by being outside and camping.

> *"I think the feeling of just being outside, even when you're not specifically learning something, you learn a lot about the environment by being out there, experiencing the surroundings, what's actually going on."*

Experiences, in and of themselves, may not engender scientific knowledge. However, when encountering the subject later, often in a formal learning environment, the experiences gained through Scouting activities become the base upon which knowledge is constructed. Scouts may not think they learn while they are camping and participating in Scouting activities, but the remembered experiences are influential in later learning. Scout B, when asked whether he learned any science while just out camping with his troop, replied:

> *"Sometimes, and sometimes no. I have to be honest about it. It's like we see some interesting things and go—hey, look at that! Maybe we look more at—what we really do focus more on—oh, that looks interesting—rather than—oh, how did that come to be? But we do some stuff like that. I think that if people can go back to that—oh, yeah, I remember that in Scouting—in their science class, then they learn. It comes right back to you how that is. . . . I think that that is very important. Those experiences we have help us a lot in the classroom sometimes. If you can remember back, even little things can probably help a lot too."*

Experiences engender questions and inquiry, leading to knowledge acquisition by engaging interest and curiosity. Scout J believed his outdoor experiences helped him in school because they caused him to question. Scout J would return to the classroom with scientific questions based on his experiences. His experiences and questions about his experiences kept Scout J interested in science and involved in the classroom.

> *J: I'd say you actually have questions. Being out there in the wilderness, you have questions about what actually is going on out there, and when you get in school, you actually discover what exactly you were looking at and how those things work, not always just how things work . . . but are actually getting to experience them, actually more fun.*
>
> *R: So you, you gained experience and questions that you were able to look at later.*
>
> *J: Yes.*
>
> *R: So, the experience made you more interested in what you were learning at school?*
>
> *J: Yes, because I had already known a little bit about some of the stuff and had questions about it that I wanted to be answered. It kept me interested.*
>
> *R: Is that why you think it helps?*
>
> *J: Probably. Because it made questions in my mind about how things work, as well as gaining experience from the wilderness.*
>
> *R: So you went in to some of your classes with questions that you wanted answered, so you were more involved in the classes?*
>
> *J: Yes.*

The merit badge program provides a more focused hands-on learning experience than camping or some other activities, giving boys fun geoscience-related experiences while directing their knowledge building in a more organized, intentional fashion.

Scouts valued the hands-on experiences gained while completing the Geology merit badge. Experiences gained through participation in the Geology merit badge encourage independent thinking by providing Scouts with hands-on knowledge of how geologists work, what geologists study, and uses for geology. The hands-on experiences, done in conjunction with the Geology merit badge, gave Scout J a perception of the work of a field geologist. Scout J stated:

> *". . . for merit badges you do have to do a lot of hands-on stuff, like, for Geology I know we had to actually go out and find a lot of the rocks and the different types of soils. And all that stuff is, scientists would too, if they're doing, like a research project or some sort of experiment that has to have a specific stuff. They have to be able to find that."*

Scouts said that doing geoscience merit badges helped them excel in school, especially if the merit badge was completed before the subject was encountered in the school curriculum. The Scouts appreciated the knowledge base they acquired as a result of doing merit badges, a knowledge base that prepared them for learning and gave them an advantage in the classroom.

R: What merit badges have helped you most in school?

J: I think I would say Environmental Science because I took—my freshman year we had a lot of environmental science, stuff we had learned about. We covered a little bit as well the geology part of it. We learned about that stuff. So.

. . .

R: You'd say Environmental Science and Geology were two, the main influential ones for you in school?

J: Well, most influential, and then Weather, just slightly. We didn't cover a whole lot of that in school work, where I learned a lot in that merit badge too.

R: Do you think you should do a merit badge in a subject before or after you do it in school?

J: I'd say before, because then you have somewhat of an understanding and it can actually help you out in school. If you're doing it afterward, most of the time you're already going to know about it, and it's not always as fun that way. It's kind of boring and kind of doing the same stuff again you already know.

R: Maybe reinforcement?

J: Reinforcement, a little bit, but, just for me, it's more fun when I learn something a little bit, and to build on that, rather just going right into it and being done with it and having to do it again in a little bit.

R: And so the doing them before, you got a base, and so you had one-up on everybody else in your class?

J: Yes.

R: Is that helpful?

J: Oh, yes, it's helpful, very much.

R: So, how often did you find that to be the case?

J: I'd say the most like the 10, the first couple weeks of school, when we were struggling, that's when we covered most of our geology and weather-type stuff and I knew most of that stuff, so I was able to be on top of things and be pretty good at that.

Experiential knowledge obtained before formal education in a subject provides a familiarity with the subject material, allowing more in depth acquisition of information. Information received in the formal education setting is filtered through personal experience and makes more sense than information not related to previous experiences. Scout D thought that the Geology merit badge was one of the merit badges that helped him most in school, crediting the experiences obtained while doing the Geology merit badge as being the most important part of doing the badge. Scouts who have previous geoscience experiences are familiar with the material and better prepared for classroom instruction.

R: What merit badges have helped you most in school?

D: I think primarily . . . when I did the Geology badge, it helped me 'cause I was doing earth science class at the time, so when I'd go into class and maybe a week later we learned something, it was like, "Oh, yeah, I remember doing that." You already . . . know what you're talking about. And, especially the Environmental Science, when you did a unit on conservation, you're like, "Oh, I already know that." So then, the information just seems to make more sense. . . . You don't have that learning block as if you're learning it for the first time.

R: So, it really helps you in school, just experientially?

D: Yeah, just by experiencing the subject matter beforehand, it really familiarizes yourself with it, and allows you to learn it better.

Geoscience education in the Boy Scouts can have many effects, from providing an experiential knowledge base for knowledge construction to providing exposure to future career opportunities. The hands-on knowledge acquired by participation in outdoor activities or in more focused merit badge activities provides Scouts with real-world experience, making science relevant and exciting scientific interest.

DISCUSSION AND IMPLICATIONS

Participation in Boy Scout programs and activities prepares boys to construct geoscience knowledge in the school classroom based on experiences, memories, and knowledge gained through merit badge participation. Scouts who completed the Geology merit badge had a 9.2% improvement in their test scores compared to the control group; therefore, the null hypothesis was rejected. The most gain of geoscience knowledge (Supplementary Fig. 1, available at: http://dx.doi.org/10.5408/09-152s4) was seen in rock features by location in strata, rock-type formation, mineral tests, and use of rocks and minerals. The least increase was seen in naming and mineral classification. These knowledge gain results correlate to the requirements of the badge—the badge requirements focus less attention on naming and mineral classification than on why the study of the present is important to understanding the past, rock formation, and rock and mineral resources and usage.

Location is an important factor in determining geoscience content knowledge acquisition by completing the Geology merit badge. A difference in the amount of content knowledge acquisition was observed between locations. Explanations may include time length of program or time to process information, strictness of adherence to the requirements, personnel, age groupings, and outside influences. Longer programs resulted in greater gain on the posttest, possible reasons being that more time was available to process information and to satisfy the "discuss" or "explain" interactions mandated for each requirement. Boys who participated in a troop Geology merit badge event were more likely to be exposed to geology content knowledge from other sources, including school geoscience classes, than were boys who participated at 1-day or 1-week events; a school–and–merit badge interaction may explain some of the knowledge gain in boys who participated in a troop event.

The landmark program was not run by the Boy Scout organization or by Scout-trained leaders, which may explain why there was less adherence to the badge requirements compared to other locations. The 3-hour Boy Scout Geology merit badge program at the landmark was a done in combination with the Cub Scout program for the Cub Scout Geology belt loop. Boys were excited about the tour and hands-on activities, but much of the information was presented in a lecture and PowerPoint presentation that may not have met the learning styles of all boys attending. Combining the two disparate age groups may have trivialized the information provided and did not allow for intense, in-depth interactions with the experiences and information for the older participants. At the landmark, the Geology merit badge mineral resources option (requirement 3) was judged complete when boys panned out minerals from a prepared sample, looked at the minerals, and identified the minerals from a picture sample list. The docent identified the samples for the group after about 5 minutes. While the boys enjoyed the panning activity, the class, origin, chemical composition, and physical properties were not addressed as specified by the requirement, negating the important connections available for geoscience learning incorporated into the requirement. The other locations adhered more firmly to the requirement as written. Excitement for and increased interest in geoscience engendered by participation in the Geology merit badge was not measured during this study. A study measuring increased interest and excitement may have revealed that earning the Geology merit badge at the landmark location engendered higher levels of interest and excitement than earning the merit badge at another location.

Scouts who participated in programs limited to Boy Scouts; run by Scout-trained personnel; adhering closely to the listed requirements and procedures, including the requirements for discussion; and lasting 6+ hours or over a week in length were, on average, more successful on the posttest. The null hypothesis was accepted: content knowledge acquired by Scouts earning the Geology merit badge at different locations varied, as shown by the differentials between pre- and posttest scores of Scouts.

The longitudinal data from the Geology merit badge indicate that Scouts who, with age and grade factored out, had completed the Geology merit badge did better on the posttest than Scouts who had not completed the merit badge. The simplest explanation for these scores is that Scouts retained the knowledge constructed while completing the Geology merit badge. A more complete explanation of the data involves combining the longitudinal data with the qualitative data from Scout interviews. For example, Scout D stated participation in the Geology merit badge helped him in school more than other merit badges because he was taking an earth science class concurrently with the Geology merit badge. The memories created while doing the merit badge helped Scout D to understand the concepts being taught in his school class by providing him with subject familiarity and allowing the information to make "more sense."

Scouts stated that doing the Geology merit badge prepared them for their earth science classes and while in their earth science classes, they built on their merit badge experiences. Experiences Scouts gained while participating in Scouting activities, including participation in the Geology merit badge, were influential in illustrating and illuminating geoscience concepts encountered in their classes. Since the Geology merit badge requirements align with National Science Education Standards (National Research Council, 1996) for earth science, the merit badge experiences and activities overlapped with geoscience content the boys encountered in school. Scouts who did the Geology merit badge constructed and retained geology content knowledge better than Scouts who did not participate in the Geology merit badge. The longitudinal posttest score data are most likely based not solely on participation in the Geology merit badge but rather on combining the merit badge experiences with other geoscience experiences, including those encountered in school geoscience classes. Participation in the Geology merit badge provides "familiarity" with the geoscience topics so that school geoscience "information just seems to make more sense." The combination of participation in the Geology merit badge and school geoscience classes may explain why the longitudinal posttest scores were higher than the posttest scores from any location except summer camp. Geology merit badge participation allows Scouts to create and retain geoscience knowledge, so the null hypothesis is rejected.

CONCLUSIONS

BSA provides opportunities for boys to experience earth and space sciences and to create lasting geoscience learning. Because merit badges align with National Science Education Standards (National Research Council, 1996), Scouts who participate in the merit badge program have experiences that mesh with standard-aligned school geoscience education. Science knowledge in a school classroom can be constructed on memories and experiences gained from participation in Scouting activities. Scouts who participate in the Geology merit badge are exposed to and participate in more focused geoscience activities and experiences than Scouts who do not and are thus better prepared to participate in and benefit from their school geoscience classes based on their experiences, memories, and knowledge. Scouts who participate in the Boy Scout Geology merit badge gain and, perhaps in combination with school experiences, retain a significantly higher amount of geology content knowledge than Scouts who do not participate in the Geology merit badge. The quality of the merit badge programs differs; adherence to the listed requirements and time for personal discovery are important.

Further study in knowledge acquisition and preparation for school classes obtained through Boy Scout geoscience programs and similar out-of-school or free-choice programs is warranted. Research on interest in science generated through participation in Boy Scout programs and similar free-choice programs should be explored. Comparison of content knowledge acquisition and retention between Scouts completing a merit badge on a subject and non-Scouts should be researched.

REFERENCES

Baden-Powell, R.S.S. 1920. Scoutmastership, a handbook for Scoutmasters on the theory of Scout training. New York: Putnam & Sons. p. 184.

Bell, J.F. 2001. Investigating gender differences in the science performance of 16-year-old pupils in the UK. *International Journal of Science Education*, 23:469–486.

BSA (The Boy Scouts of America). 1998. Boy Scout handbook. Irving, TX: Boy Scouts of America. p. 472.

BSA (The Boy Scouts of America). 2005. Values of Scouts: A study of ethics and character. Irving, TX: Boy Scouts of America.

BSA (The Boy Scouts of America). 2008a. Boy Scout Requirements 2008. Irving, TX: Boy Scouts of America.

BSA (The Boy Scouts of America). 2008b. Boy Scouts home page. Available at http://www.scouting.org/.

BSA (The Boy Scouts of America). 2008c. Scoutreach. Available at http://www.scoutreachbsa.org/ (accessed 26 January 2009).

Campbell, D.T., and Stanley, J.C. 1963. Experimental and quasi-experimental designs for research. Boston: Houghton Mifflin Company.

Corbin, J., and Holt, N. 2005. Grounded theory. *In* Somekh, B., and Lewin, C., eds., Research methods in the social sciences. London: Sage Publications, Ltd., p. 49–55.

Falk, J.H., and Dierking, L.D. 1997. School field trips: Assessing their long-term impacts. *Curator*, 40:211–218.

Garrison, J.R.J., and Endsley, G. 2005. Field-based geoscience education—A valid experience in outdoor education. *The Texas Science Teacher*, 34:23–29.

Heard, P.F. 2000. Can "ears-on" help hands-on science learning for girls and boys? *International Journal of Science Education*, 22:1133.

Hlawaty, H. 2002. Comparative analysis of the learning styles of German adolescents by age, gender, and academic achievement level. New Orleans, LA: American Educational Research Association.

Honigsfeld, A., and Dunn, R. 2003. High school male and female learning-style similarities and differences in diverse nations. *Journal of Educational Research*, 96:195.

Jarman, R. 2005. Science learning through Scouting: an understudied context for informal science education. *International Journal of Science Education*, 27:427–450.

May, M.T., and Gibbons, M.G. 2004. Introducing students to environmental geophysics in a field setting. *Journal of Geoscience Education*, 52:254–259.

National Research Council. 1996. National Science Education Standards. Washington, DC: National Academy Press.

Nicholson, E. 1940. Education and the Boy Scout movement in America. New York: Teachers College Press.

Schugurensky, D. 2006. This is our school of citizenship: Informal learning in a local democracy. *In* Bekerman, Z., Burbules, N.C., and Silberman-Keller, D., eds., Learning in places the informal education reader. New York: Peter Lang Publishing, p. 163–183.

Silberman-Keller, D. 2003. Toward the characterization of non-formal pedagogy. *In* Annual Meeting of the American Educational Research Association. Chicago, IL: American Educational Research Association.

Steele, B. 2008. Merit badge control (personal communication with author, 2 July 2008).

Stocklmayer, S., and Gilbert, J. 2002. New experiences and old knowledge: Towards a model for the personal awareness of science and technology. *International Journal of Science Education*, 24:835–858.

Talburt, S. 2004. Ethnographic responsibility without the "real." *The Journal of Higher Education*, 75:80–103.

Wellington, J. 1990. Formal and informal learning in science: The role of the interactive science centres. *Physics Education*, 25:247–252.

SUPPLEMENTARY MATERIALS

BOY SCOUT GEOSCIENCE MERIT BADGES ALIGNED WITH NATIONAL SCIENCE EDUCATION STANDARDS

Supplementary Table I (available at http://dx.doi.org/10.5408/09-152s1) has two sections, because National Science Education Standards (National Research Council, 1996) differ for grades 5–8 and grades 9–12. In the table, the number 1 represents a requirement, 0 represents an option, and a blank cell indicates the requirement is not met by the merit badge's program of study. Hatch marks and color indicate an Eagle-required badge. The Geology merit badge has four options for study: (1) surface and sedimentary processes (category A), (2) energy resources (category B), (3) mineral resources (category C), and (4) earth history (category D). In the additional geology line at the bottom of each National Standards section, the letter of the option was used in place of the number 1 to indicate a requirement for that option. All four options contain the same preliminary requirements before the Scouts choose an option with which to complete the badge. (Note: the requirements for the Geology merit badge were revised slightly, effective January 2010, but the National Science Education Standards met by the badge requirements were not impacted by the changes.)